SPACEX: BREAKING THE BARRIER TO THE SPACE LAUNCH VEHICLE INDUSTRY

THESIS

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Abstract

The Space Launch Vehicle (SLV) industry has been around for a long time, but few companies have managed to enter this industry. SpaceX was founded only 10 years ago, but it has managed to become a leader in the United States (U.S.) industry and a dominant player worldwide. The purpose of this thesis research is to discover what it took for SpaceX to break into this tightly controlled industry. A qualitative analysis was performed to compare SpaceX to companies that overcame the barriers of entry for their respective industries. SpaceX, like FedEx, implemented a unique technique to the industry and found success. SpaceX was also evaluated against guidelines and principles presented by relevant research. The results of this research showed that SpaceX, driven by Elon Musk, overcame the barriers of entry primarily through their large initial investment and implementation of vertical integration. This research showed SpaceX adhered to the guidelines and avoided misconceptions associated with implementing vertical integration. Musk, following value innovative principles, is using the concept of reusability to decrease the cost of an SLV. The results of this research show that the U.S. Air Force can aid other companies in the future to create a healthier competition in the SLV industry.

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I. Introduction

Today's technology provides an environment in which many start-up companies often challenge the status quo of an industry. However, this is not true of all industries, and in some cases, it is nearly impossible to enter an industry because of the strong hold a few companies maintain. The Space Launch Vehicle (SLV) industry is one such industry that has been controlled by a few huge companies since the beginning of space exploration. However, Space Explorations Technologies Corporation (SpaceX) entered the SLV industry in 2002 with no experience and is now changing the way business is performed in this once tightly controlled industry. Therefore, the purpose of this research is to understand what it took for SpaceX to jump into the SLV industry by comparing their innovative techniques and business practices to other industries. This research should help the government identify companies and technologies early in their life-cycle that have the potential to break into the SLV industry and provide a lower cost.

Background

The SLV industry, like any industry, has certain barriers for new entrants to overcome. Research has shown there are two distinct types of barriers, revealed and deterring, to innovation (D'Este, Lammarino, Savona, & von Tunzelmann, 2012). Revealed barriers are those that involve the lack of knowledge of an entity and its ability to fight difficulties. These barriers can

often be overcome with education and experience in a specific area. Deterring barriers are generally those which an entity believes they have no control over and cannot be directly overcome. D'Este et al. (2012) analyzed survey responses from companies about what hampers innovation in their company or industry. This resulted in four subcategories of these barriers that hamper innovation: cost, knowledge, market, and regulation (D'Este et al., 2012). These two concepts of barriers (i.e., types and categories) were then combined to discover which barriers firms should concentrate on when entering a new market. The research showed that cost and market barriers can fit into both revealed and deterring, depending on the specific industry (D'Este et al., 2012). Cost can be a deterring factor when an outside material or service is required for entry, but it can be a revealed factor when producing and providing services internally. Market barriers fit into both categories because often a market cannot be controlled, but a greater understanding of the market can allow a firm entry into it. Knowledge is a revealed barrier because greater experience and training solve the problem of a lack of information. Regulation is on the opposite end of the spectrum because there are often policies and government bodies that dictate specific ways a product or service must be offered. Since it takes effort to change most regulations, this is not an option for most new entrants (D'Este et al., 2012). SpaceX or any company with the desire to enter the SLV industry must understand how these concepts relate to that industry and identify a strategy to break through the barriers.

SpaceX, unlike any other SLV company, implemented a vertical integration strategy to overcome the industry barriers. As defined by The Economist (2009), "Vertical integration is the merging together of two businesses that are at different stages of production." In the case of SpaceX, this applies to the manufacturing, assembling, and launching of the SLV. The benefits and disadvantages of vertical integration have been a controversial topic among researchers for

years. Some researchers have discovered that vertical integration may be a cause for an industry's decline, such as the United States (U.S.) automobile industry, because it restricts a company's ability to innovate (Hayes & Abernathy, 2007). The president of Commodore argued this point stating, "It's well worth it … to be able to get into and out of a technology when you want to" (Why They're Integrating into Integrated Circuits, 1974). It is harder for a company to change its business when it is invested in multiple states of a product. The more products or services a company is invested in, the harder it is to innovate on those individual concepts. Additionally, a company will often not see outside sourcing on products and services they already provide. In this case, bigger can be worse.

Buzzell (1983) examines the concept of vertical integration to determine in what context it is beneficial to a company and when vertical integration can hurt a company. Buzzell's (1983) research resulted in five guidelines for determining whether vertical integration is the right choice for a company: beware of heightened investment needs, consider alternatives to ownership, avoid part-way integration, carefully analyze scale requirements, and be skeptical of claims that integration reduces raw material costs. Vertical integration often requires a significantly larger investment, so a company considering vertical integration must ensure they can keep a positive return on investment before risking the capital (Buzzell, 1983). The research also showed that companies should also consider alternatives to owning different parts of the industry, such as creating better partnerships and long-term contracts with suppliers. An all-or-none approach is best when applying vertical integration, either avoid the concept all together or ensure the technique is being fully applied to the business model (Buzzell, 1983). However, firms should carefully analyze scale requirements before adapting vertical integration techniques. As stated by Buzzell (1983), "A significant risk in many vertical integration strategies is that a

production or distribution stage has too small a scope to be run competitively against independent suppliers or customers." Vertical integration does not always mean a reduction in raw material costs; therefore, a company needs to ensure they are not making that assumption when attempting the conversion to vertical integration (Buzzell, 1983). Buzzell sums up these points with the following statement.

> All of these guidelines may seem unduly negative. Each points to possible dangers or illusions associated with increased vertical integration. Given that integration strategies often involve big investments; caution does seem advisable. On the other side, however, vertical integration is often a highly successful strategy. Especially for businesses and companies that enjoy strong market positions, increased integration can pay off in both profitability and greater product innovation. (Buzzell, 1983)

Different innovation techniques can be used to help overcome entry barriers to an industry. Innovation by simple definition does not equate to success or profitability of an idea, just something new (Merriam-Webster, n.d.). Researchers have concluded that innovation is "an iterative process initiated by the perception of a new market and/or new service opportunity for a technology based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention" (Garcia & Calantone, 2002). With a base definition of innovation, it is important to understand how this can help a company overcome barriers. For example, researchers have explored how a company can benefit from innovation (Jacobides, Knudsen, & Augier, 2006). Specifically, Jacobides et al. (2000) compares the gains of innovation to the losses of value sharing ideas. Companies often suffer from the fear of lost value in innovating just to have their ideas replicated or enhanced by competing firms, but it is important for companies to concentrate on how they can generate value from their innovations and not how to protect their innovations (Jacobides et al., 2006).

Kim and Mauborgne (1999) postulate that if an industry becomes saturated with competition instead of innovation, those competing will suffer from certain unintended effects and often fail.

Additionally, instead of innovating to gain the competitive edge, companies will often start imitating and simply trying to do the same thing slightly better. This leads to the result that creating growth opportunities is usually left behind in favor of responding to short-term competitive moves. Additionally, "A company's understanding of emerging mass markets and changing customer demands becomes hazy" (Kim & Mauborgne, 1999). In general, value and innovation are both important to a business and one should not be ignored in favor of the other.

Value innovation is a term used to describe a business approach that focuses on creating new market spaces as opposed to competing for market share. A company's value innovation comes from the top, so leaders play a key role in the relationship between innovation and the company's success. If the value of innovation is going to be an important part of what a company wants to achieve, it will require "top management [to] clearly communicate the company's commitment to value innovation" (Kim & Mauborgne, 1999). Their research also showed that for a company to be value innovative, they must have small autonomous teams that focus on a function rather than the entire organization.

Since the Chief Executive Officers (CEO) and leadership are such an important part of why a company enters an industry, it is useful to understand the motivations of leaders. There are two basic theories that drive the motivation of executives: *agency theory* and *stewardship theory* (Barney, 1990). *Agency theory* suggests that management's priority is self-interest for fear that shareholders will diversify their personal portfolios (Barney, 1990). Hill and Jones (1992) explain, "The cornerstone of agency theory is the assumption that the interests of principles [management] and agents [shareholders] diverge." In general, owners become principals when they contract others to manage their firms and these agents look at their role just as a contract and not a true partnership or desire to help the principal's organization (Davis, Schoorman, &

Donaldson, 1997). Researchers have proposed a new paradigm to *agency theory* that accommodates the desire for power and resource dependence of organizations (Hill & Jones, 1992). This implies there is more to agency theory than the desire to keep self-interest the number one priority.

Stewardship theory, in contrast, advocates that managers are not motivated by self-interests, but rather their motives are aligned with the goals of their organization or company (Davis et al., 1997). The big difference here is that stewards will always put the company first, whereas principals will always put themselves first. Research shows that stewards help a company progress and in turn benefit all parties involved (Davis et al., 1997). Davis' research also emphasizes that even though, in almost every case, it is better to be a steward, there is significantly more risk involved and this tends to be too much of an all-in business perspective. According to their model, a manager must choose at some point if he/she will become a principal or steward in the company and this choice is normally based on psychological motivations and personal perceptions of the situation (Davis et al., 1997). More recent research takes this theory a step further to suggest that this choice is based on when a manager aligned himself/herself with the company (Wasserman, 2006). Founders are more likely to be stewards and accept higher risk because the company most likely represents their vision, as opposed to non-founders who were not there at inception and only later bought into the organizational goals (Wasserman, 2006). Understanding these theories will help determine which philosophy leaders follow in tightly controlled industries.

Problem Statement

The SLV industry is relatively small and leaves few options for customers to "shop around" to different companies. With an average cost to the U.S. Air Force of $225 million dollars from the United Launch Alliance (ULA), it is very expensive to launch a satellite into space (United Launch Alliance, 2015). This creates a problem for the U.S. Air Force because there are no other options, which leads to great risk for U.S. taxpayers. However, when SpaceX entered the industry and started taking on more projects, another option became available to launch satellites into space. In 2015, the U.S. Air Force authorized SpaceX to launch national security missions, thereby providing a second option to the government. Even with two options to satisfy national security, there is still a need to discover if more competition can be created. It is possible that a new company could enter this tightly controlled industry and offer more cost-effective SLV services than anyone in the business for decades. Therefore, the purpose of this research is to investigate and understand what innovations and techniques were employed by SpaceX to break into the SLV industry. This research will allow the Air Force and U.S. government to understand what steps they could take in the future to facilitate healthy competition and reduce the cost of SLVs even further.

Part of this research focused on comparing and analyzing SpaceX's use of vertical integration to determine if this technique is a source of their success. Additionally, the research examined some of Elon Musk's key decisions with SpaceX in an attempt to help predict the best approach in determining if a tightly controlled industry can be entered. SpaceX is a private company that got its start from the investment of one person, meaning the company's value innovation had to start at the top with the CEO. Therefore, a portion of this research will also explore the values of SpaceX's leadership and more specifically the CEO, Elon Musk.

Research Questions

This research is motivated by a desire to determine how a company can break into such a tightly controlled industry so that the Air Force can use this information to encourage more competition in the SLV industry. SpaceX has grown rapidly since its start in 2002 and currently has over 5,000 employees. More specifically, SpaceX was studied due to their recent success. In May of 2015, SpaceX became only the second provider to be certified by the Air Force to launch National Security Classified payloads. This makes SpaceX an ideal company to study to develop a better understanding of how the SLV industry can be transformed.

Several key questions were defined to comprehend the innovation and techniques SpaceX used to successfully enter the SLV industry.

1. Why did Elon Musk/SpaceX want to enter the SLV industry? How does this compare to other leaders and companies who entered tightly controlled industries?
2. What are the barriers to entry in the SLV industry? How does this compare to other tightly controlled industries?
3. What key innovative techniques did SpaceX implement?
4. How do SpaceX leaders value innovation versus other industries?

Methodology

The research methodology is qualitative and comparative in nature. Generating data began with a literature review into the history of the SLV industry and innovation principles. It was additionally important to research the SLV industry and the factors that make it so difficult to enter. Other industries with little competition and a high barriers to entry were also examined to provide a basis of comparison. This information represented a case study approach in which data from other successful companies was explored and analyzed. Qualitative data about the

industries were primarily used, but quantitative data was considered when available. Information gathered from other companies was compared to what is known about the SLV industry and SpaceX to draw parallels and discover the most significant factors that made SpaceX successful in breaking into a tightly controlled industry. The research concludes with a summary of findings and recommendations to identify and assist more competition. Chapter III will provide more details about the research methodology.

Preview

This chapter introduced the research by providing a background on the history of the SLV industry, along with some useful definitions of innovation. Additionally, the chapter provided a description of the problem, research questions to be answered, and the methodology of the research. Chapter II will present a literature review to form the basis to answer the research questions and pave the way forward for the bulk of the research. Chapter III presents a description of the methodology used to perform the research, while Chapter IV describes the results of the research and outlines the analysis. Lastly, Chapter V delivers the conclusions and presents recommendations for future studies

II. Literature Review

The purpose of this chapter is to provide background into the Space Launch Vehicle (SLV) industry and its major competitors. This will provide an understanding of the foundation of the industry and how the barriers of entry developed. This chapter also provides background into relevant research into innovation, concepts of which can be used to evaluate the actions and mission of SpaceX. Furthermore, the literature review provides background information about other industries having high barriers to entry but that were overcome by smaller companies, such as FedEx and the postal service industry.

Space Launch Vehicle Industry History

In the early years of space technology, the government controlled all aspects of space launches and the vehicles used for those launches. The first artificial Earth orbiter, Sputnik, was launched using a modified Russian Intercontinental Ballistic Missile (ICBM) on October 4th 1957. This R-7 Semyorka was the first ICBM and, in turn, the first true SLV. Explorer-I, the first United States (U.S.) space launch, used the Jupiter-C SLV on January 31st 1958. As with the Russian SLV, this was a modified version of a U.S. ICBM (the Redstone ICBM). Since a warhead and satellite are normally of similar mass and size, it is very common for ICBM launch vehicles to be modified for satellites. This was especially true during the Cold War era when little funding existed for space activity.

Telstar 1 was the first fully commercial object launched into space on July 10th 1962. It was launched by the National Aeronautics and Space Administration (NASA) using a Thor-Delta SLV. Telstar 1 thus marked the integration of private companies into the space industry. Prior

to the Commercial Space Launch Act of 1984, only NASA was permitted to launch satellites into space; commercial companies were forced to have their payloads launched by NASA. This Act ignited the SLV industry, because commercial companies could now enter and create an industry that did not exist. In 1990, a new law was passed by Congress that forced NASA to use commercial space launch vehicles when possible. This law essentially formed a new multi-billion-dollar industry, and there are currently about ten active space launch providers throughout the world.

Most SLV providers are tightly linked to governments and are not true commercial companies competing for industry share. Antrix Corporation is the commercial sector of the Indian Space Research Organization. Founded in 1992, it is owned entirely by the Indian government. Currently, Antrix provides SLV services to Europe, the Middle East, and Southeast Asia. Arianespace was founded in 1980 as the world's first commercial SLV company. The French government owns a majority of the company, with offices in French Guiana, United States, Japan, and Singapore. Arianespace was once responsible for more than 50 percent of the world's space launches to geostationary orbit. China Aerospace Science and Technology Corporation (CASC) is the state-owned private company responsible for a significant portion of the Chinese space launches. CASC was founded in 1999, but its roots date back to 1956 in the defense industry. International Launch Services (ILS), founded in 1995, is a joint venture between Lockheed Martin and Russian Khrunichev. In 2008, Khrunichev acquired full ownership of ILS from Lockheed, but ILS remains a partial U.S. company with an office in Virginia. Orbital ATK is a U.S. company formed in 2015 from Orbital Sciences Corporation and Alliant Techsystems. Sea Launch was a multi-national venture formed in 1995 to provide launch services to geostationary orbit. Launches were performed on old oil platforms to save on launch

costs. The company has recently halted operations considering recent complications with acquiring its Russian rockets. United Launch Alliance (ULA) is the joint venture between Lockheed Martin and Boeing initiated in 2006. This is the world's largest private space launch company with its primary focus on the U.S. government as a customer. ULA was responsible for all U.S. military launches until 2016 when SpaceX won a U.S. Air Force contract.

SpaceX was founded in 2002 entirely from private funds. The primary goal of SpaceX is to create technologies to reduce space transportation costs and enable the colonization of Mars (SpaceX, n.d.). SpaceX has achieved many firsts in the SLV industry, including the first privately funded liquid propellant rocket in 2008 and the first privately funded company to launch, orbit, and return a spacecraft in 2010. Space X was likewise the first private company to send a spacecraft to the International Space Station (ISS), accomplishing this feat in 2012. SpaceX is working on a unique approach to the SLV industry in which they plan to reuse the first stage of their rockets to reduce expenses (SpaceX, n.d.).

Relevant Research

In addition to developing a broad understanding of the SLV industry and its history, it is important to understand other relevant research to acquire an understanding of the topics to be discussed. The fundamental basis of this research is innovation and innovative concepts used by other companies. For instance, research into the postal service industry will provide parallels and an understanding of the industry and why it is relevant to the SLV industry. Leaders, and founders more specifically, control the overall direction and mission of any business, thus making it imperative to understand how they make decisions. Elon Musk, the founder and

controlling power at SpaceX, deserves significant attention into his past and motivations. These topics will provide the foundation for this research.

SpaceX

SpaceX has managed to break into a very tightly controlled industry with little experience. This makes SpaceX the ideal candidate to research to determine the way forward in encouraging competition that will benefit the U.S. Air Force. Therefore, it is important to verify that SpaceX has broken into this industry and is a viable competitor. Figure 1 shows data collected and analyzed from Federal Aviation Administration (FAA) licenses granted over the last six years for space launches (Federal Aviation Administration, 2016). Since this is based on FAA licenses, it does not include launches that occurred outside of U.S. airspace. This data shows not only a significant increase in recent years of SpaceX activity, but it also shows that SpaceX now has the clear majority of U.S. SLV business. Figure 2 shows worldwide launches over the last six years, which indicates that SpaceX is gaining market share worldwide. SpaceX has thus proven to be a company on the rise and a major player in the U.S. and worldwide SLV industry.

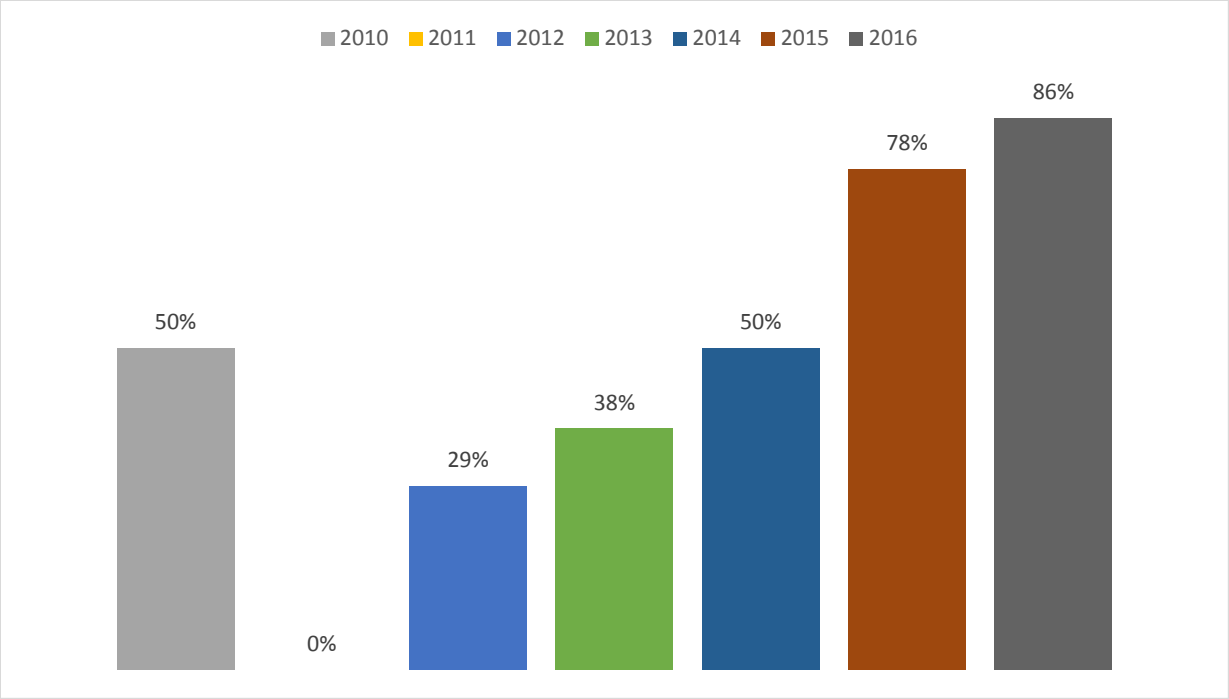

Figure 1. SpaceX Percent of FAA Licenses

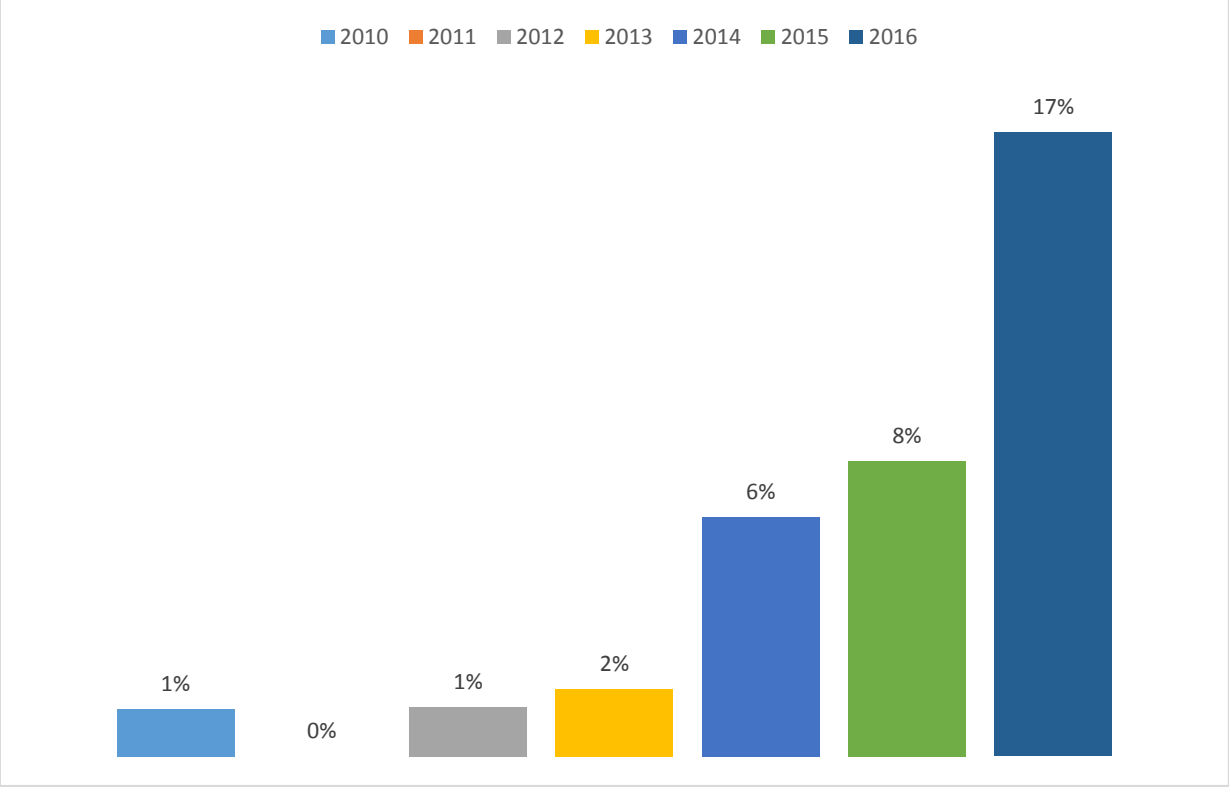

Figure 2. SpaceX Percent of Worldwide Launches

Elon Musk

Elon Musk (or any CEO for that matter) is the head of the company and the main creative driver for a company. Therefore, it is important to understand what drives the CEO in order to understand what drives the company. Musk was born on June 28th 1971 and has been credited with many innovative concepts and companies other than SpaceX. Musk graduated high school in South Africa and then moved to Canada to attend Queen's University in Ontario. He always wanted to go to the United States but knew it would be much easier to become an American by first moving to Canada where his mother was from and then transitioning to the United States (Junod, 2012). Musk then attended Stanford with the goal of getting a graduate degree in applied physics, but he dropped out in 1995 to work on his first business venture with his brother. The first innovation Musk was involved with was helping news outlets get their media onto the internet under the company Zip2 (Lubove, 2003). Musk then took to another internet venture in the form of creating a way to send money electronically via email, this was the basis of what became PayPal (Lubove, 2003). After founding SpaceX, Musk started Tesla and came up with an innovative technique for designing cars by focusing only on one model at a time and making sure it met all requirements before spreading out to other models (Ritson, 2014).

Musk has a personality wherein he wants to be part of, and advance the changing world, especially in the technology industry. He predicts that the three things that will greatly affect the world in the next few decades are the internet, sustainable energy, and multi-planet life (Jacoby, 2011). He eventually tackled all three of these concepts. After he sold his first company, Zip2, and became a millionaire, he then started X.com, which became PayPal. Musk did not stop there, as he entered the space industry. At that time, no one was looking at multi-planetary exploration, so Musk invested most of his wealth into SpaceX, which many investors thought

was unwise (Jacoby, 2011). While still managing SpaceX, Musk wanted to help the planet and push for sustainable energy and did so by creating Tesla with the goal of creating affordable electric cars. He subsequently became chairman for SolarCity, with the purpose to concentrate on clean energy. Musk's strongest desire is to help society and advance technology. He has even released most of his technology patents to allow other car manufactures to create more electric vehicles because he believes this is the way of the future and wants to make sure the technology does not die (Jacoby, 2011). As a testament to his dedication, Musk endured three straight launch failures with SpaceX and a possible bankruptcy at Tesla by investing the last of his money into his company.

Musk is an innovator who has had many things help and hinder his vision. His determination is one of the greatest factors that helped him innovate. He managed to teach himself most of what he knows just by reading and did not let short-term failures destroy SpaceX and Tesla (Jacoby, 2011). The U.S. government assisted in many of Musk's ventures because these companies focus on sustainable energy and advancing society in general. His rise to success has not been unimpeded though. Not only has Musk fought failures within the company in terms of technology, but there has been a lot of resistance from outsiders who would rather stop change and the advancement of technology to keep the status quo (Jacoby, 2011). Musk has been involved in multiple lawsuits involving journalists and former employees who wanted to see the electric car fail (Jacoby, 2011). Overcoming a high barrier to entry also impeded Musk's ventures into the space and automobile markets. Despite all of these difficulties, Musk has pushed his visions forward to make all of his ventures successful.

Innovation

Very broadly, innovation is defined as a new idea, method, or device. This is a rather broad definition, but it provides a starting point for understanding whether something is considered an innovation. Christensen (1997) broke innovation into two major categories: sustaining innovation occurs when the technology or concept facilitates the improvement of a current technology, while disruptive innovation brings forth a new value or asset that had not been previously available. Sustaining innovations are the most common and are frequently used by large well-established companies to maintain their industry share. Disruptive innovations are technologies which break into the status quo of an industry and provide a new option to customers. These innovations tend to be the most interesting and what inventors dream of creating. Table 1 shows a list of some historical disruptive innovations and the corresponding technology they overcame (Christensen, 1997). Christensen (1997) even goes as far as to emphasize that incumbent firms will always lose the battle to disruptive technologies. However, this idea is not accepted by all; for instance, Tellis (2006) believes there are a lot of holes in Christensen's work and a lack of detail. Tellis (2006) believes that a company's vison and leadership are more likely to cause a loss to disruptive technologies. No matter the opinion of the effects of disruptive innovation, it is a controversial topic and should be considered by most companies.

Table 1. Established vs. Disruptive Technologies (Christensen, 1997)

Established Technology	**Disruptive Technology**
Silver halide photographic film	Digital photography
Wireline telephony	Mobile telephony
Circuit-switched telecommunications networks	Packet-switched communications networks
Notebook computers	Hand-held digital appliances
Desktop personal computers	Sony PlayStation II, Internet appliances
Full-service stock brokerage	On-line stock brokerage
New York & NASDAQ stock exchanges	Electronic Communications Networks (ECNs)
Full-fee underwriting of new equity and debt issues	Dutch auctions of new equity and debt issues, conducted on the internet
Credit decisions based upon the personal judgment of bank lending officers	Automated lending decisions based upon credit scoring systems
Bricks & mortar retailing	On-line retailing
Industrial materials distributors	Internet-based sites such as Chemdex and E-steel
Printed greeting cards	Free greeting cards, downloadable over the internet
Electric utility companies	Distributed power generation (gas turbines, micro-turbines, fuel cells)
Graduate schools of management	Corporate universities and in-house management training programs
Classroom and campus-based instruction	Distance education, typically enabled by the Internet
Standard textbooks	Custom-assembled, modular digital textbooks
Offset printing	Digital printing
Manned fighter and bomber aircraft	Unmanned aircraft
Microsoft Windows operating systems and applications software written in C++	Internet Protocols (IP), and Java software protocols
Medical doctors	Nurse practitioners
General hospitals	Outpatient clinics and in-home patient care
Open surgery	Arthroscopic and endoscopic surgery
Cardiac bypass surgery	Angioplasty
Magnetic resonance imaging (MRI) and Computer Tomography (CT) scanning	Ultrasound - initially floor-standing machines, ultimately portable machines

Other researchers have added two additional categories to emphasize that any innovation can be broken into one of four categories: breakthrough, disruptive, new market, and sustaining (Nielson, 2014). Breakthrough innovation is considered "a large, discrete step change in performance, technology, and value provided to users" (Nielson, 2014). Light Emitting Diode (LED) backlighting technology for televisions is one such breakthrough. LEDs provide a smaller, more energy efficient and longer lasting solution to backlighting TV displays. Disruptive innovations tend to be a step in a simpler direction intended to expand the product to more customers. One recent example of this is the operating system on the iPhone. At its core, the software is just a simplified version of the operating system found on Mac computers. A simple operating system was easier for users to navigate on smaller phone screens. A new market innovation is not your traditional innovation in the fact that little of the technology is generally changed. The innovation comes in the form of a new way to use an existing product or technology. One classic example of this is baking soda. Arm and Hammer originally marketed this product for baking but noticed customers were putting it in the refrigerator and using it as a deodorizer. Since baking soda was cheaper than most deodorizers, it turned out to be a better alternative in many cases. Arm and Hammer simply started marketing their product as multi-purpose, thus allowing them to enter a new industry. Sustaining innovations are typically easy to find, especially in areas of technology. Every year, new phones come out that provide sustaining innovations over the previous model. This often comes in the form of better battery life or simple feature additions and optimizations. These innovations are expected by customers today. Reusability is a breakthrough innovation that has not been widely implemented in the SLV industry.

Leadership and the Value of Innovation

Value innovation is a term used to describe the strategy used by companies with sustained high growth and profits (Kim & Mauborgne, 1999). Their research suggests that, "value innovation makes the competition irrelevant by offering fundamentally new and superior buyer value in existing markets and by enabling a quantum leap in buyer value to create new markets." This is contrary to the idea of building levels of competitive advantages and striving to outperform the competition. This differs from normal innovation in the fact that value innovation implies a jump in value, not necessarily with the use of new technology. Kim and Mauborgne (1999) show that there are three unintended consequences of companies who compete rather than value innovate: imitate instead of innovate, react instead of grow, become lazy to customer demands. Their research also posed two questions to companies to determine if they were value innovating: (1) is the company offering customers a radically superior value and (2) is the price level accessible to the mass buyers of the targeted market. If a new and superior product or service is too expensive, another company will likely benefit from their early research and development.

Research of Fortune 500 companies employing value innovation showed that two common components could be found in these companies (Kim & Mauborgne, 1999). First, pricing strategically leads to a high volume of sales and a powerful brand reputation. Second, targeting cost will lead to attractive profit margins and a structure that will be hard for followers to match. Companies following these practices tend to capture the core of expanded markets and not necessarily destroy the competition since they are creating new demand. The research also shows that employees at all levels want acknowledgment for their intellectual and emotional worth towards value innovation (Kim & Mauborgne, 1999). This is done by exercising a fair

process based on three important principles. First, people want to be engaged in decisions that affect them. Second, people want to have explanations of final decisions even if it is not the outcome they desired. Finally, people desire clear expectations of their actions and deliverables. In general, value innovation can fuel small companies to break into an industry and grow profitably or regenerate the fortunes of big companies (Kim & Mauborgne, 1999).

Roberts and Fusfeld (2004) examined technology-based innovation processes in terms of the people and functions that should make an organization effective at innovating. Researchers broke the innovative process into six stages: pre-project, possibilities, initiation, execution, outcome evaluation, and transfer. The important part for leadership is understanding the roles in the process and the types of people who will fill those roles. The five critical work functions are idea generating, entrepreneur or championing, project leading, gatekeeping, and sponsoring or coaching (Roberts & Fusfeld, 2004). The research emphasizes that it is not a one-to-one ratio; some roles will be fulfilled by multiple people, some people will fulfill multiple roles, and roles will typically change over a person's career with an organization. Since people frequently do things for which they get rewarded, it is important for an organization to properly reward people in each of those critical positions. If the leadership in an organization values innovation, they will likely follow the innovative process and spend extra time selecting people for the critical functions in the process.

Research has shown that innovation occurs throughout an entire company and is broken into three micro cultures: the "Fuzzy Front End," the product development process, and business operations (Zien & Buckler, 2000). The Fuzzy Front End is the unpredictable side of a company where most of the experimentation occurs and leaders are willing to accept ambiguity and give individuals more autonomy. The product development process is much more disciplined and

committed to goals; teamwork is significantly more important in this micro culture. The business operations portion seeks predictability and order to establish values within the organization. This micro culture is significantly larger in size compared to the other cultures and focuses on rules and routines. Zien and Buckler (2000) studied innovative companies and discovered that senior leadership develops and sustains an environment that simultaneously enforces all three micro cultures and includes many feedback loops between the micro cultures. Even if a successful innovative company does not explicitly state their attention to these micro cultures, it can be found in their practices.

Reusable Launch Vehicles

Reusable Launch Vehicles (RLVs) have been theorized and a goal for the space industry for many years. The U.S. Air Force has been funding research into RLVs for decades and spent approximately $115 million on that research between 1992 and 1997 (Ward, 2000). The space shuttle is the most well-known use of reusable technology. Faget first developed the concept of a two-stage fully-reusable shuttle, then many other designers expanded on this to develop the space shuttle that was first launched in 1981 (Heppenheimer, 1999). Unfortunately, the space shuttle was not a fully reusable system and after each launch the external tank and vehicle load frame were destroyed. There has yet to be a fully-reusable launch system developed.

The concept of RLVs has one huge attractive aspect in that they potentially will reduce the cost of launching payloads to space. Due to the kinetic forces exerted on a SLV during launch and return, the SLV must be designed to be sturdier than expendable launch vehicles but still lightweight to get any relevantly sized payload into orbit (Ward, 2000). Ward (2000) performed a study to determine how much technology needed to advance to make RLVs a feasible product.

Since an SLV needs to take all of its fuel into space, it will traditionally discard its fuel tanks to save mass and effectively get a larger payload to space. Today, there are two approaches to SLV design: single-stage and two-stage SLVs. In the single-stage design, the SLV can be much lighter because there are fewer tanks and engines required, but this approach fails to optimize fuel efficiencies in different environments (Ward, 2000). The two-stage approach is heavier and more complex because there are at least two different tanks and engines on the SLV. This approach has the benefit of optimizing the first stage for operations in the atmosphere, then optimizing the second stage for operations outside of the atmosphere (Ward, 2000). Ward's research makes note that either approach could be applied to an RLV. Relatively speaking, fuel is one of the least expensive parts of a space launch; if the entire system can be reusable, the only loss after a launch is the fuel (Ward, 2000). If the only loss is the fuel, there would be a significant reduction in the cost to launch a payload to space, minus the cost of research and development in addition to the initial cost of physical materials and manufacturing.

The problem with creating an RLV is the cost of research and materials. Ward (2000) explains, "of the numerous technical challenges to achieving the required operability and reliability, the principal are thermal protection systems, reusable propulsion systems, non-toxic propellants, lightweight structures and components, and integrated launch vehicle health monitoring systems." Just looking at material cost for all of this, a company must develop a launch vehicle that is made of components that can survive many launches. The first calculation that must be performed for any potential RLV is how many times it must survive launch to break even on the more expensive material cost (Ward, 2000). Then the cost of research and development can be factored into the finances since this technology does not yet operationally exist.

Postal Service Industry

When it comes to shipping, there are very few options one can utilize. Today, customers can choose from the United States Postal Service (USPS), United Parcel Service (UPS), Dalsey Hillblom Lynn Express(DHL), and Federal Express Corporation (FedEx). The United States Continental Congress established the official USPS on July 26th 1775. UPS, the world's largest package delivery company, was founded on August 28th 1907. DHL, the world's largest logistics company, was established in 1969. FedEx, who pioneered overnight delivery, commenced operations on April 17th 1973. These four companies comprise the postal service stronghold with little variation since FedEx entered the market.

The USPS is the United States' oldest established mail service and therefore has the most experience in this industry. Panzar and Watson (1991) even goes as far to describe the USPS as a "technological natural monopoly" and that competition should proceed with caution. If an industry has a natural monopoly, it means it is less costly to the consumer if a single firm operates the goods or services as opposed to multiple firms (Panzar & Waterson, 1991). In some sense, this remains true today because none of the other competitors can send a one-ounce letter for only 47 cents. It is important to note that a natural monopoly is not necessarily a bad thing, a point discussed in Panzar and Watson's (1991) research: "If a natural monopoly is producing and pricing as efficiently as possible, there is no need to bar competitive entry: it is economically unnecessary and will not take place anyway."

Dietl and Waller (2002) performed research in the international postal service industry with the goal of discovering how countries can facilitate healthy competition in their mail services. In general, the industry process can be divided into five major activities: collection, outbound sorting, transportation, inbound sorting, and delivery (Dietl & Waller, 2002). This makes the

service very complicated because the process is very segmented and requires a very large infrastructure. Cost is nearly impossible to standardize as well because of these factors. It is physically more expensive to deliver mail to rural areas versus dense cities, but the price to mail a letter does not change in the United States based on location. This standard pricing is in general due to regulations, but it makes it nearly impossible for an entrant to compete (Dietl & Waller, 2002). This is likely the reason no other company provides standard mail services in the United States.

Dietl and Waller's (2002) research came up with seven business models that new entrants could take advantage of to break into this market, as shown in Figure 3. One of the most favorable models overall is for a company to create networked local mail services where mail is only delivered in a high-density area to minimize costs (Dietl & Waller, 2002). Entrega en Mano of Spain is a successful company using this business model and one could see the potential in a city such as New York, where less expensive mail services could be offered for letters delivered to and from the city. Another highly favorable business model is the consolidator approach. This takes advantage of the fact that most mail services are cheaper for large volume corporate customers. A consolidator would unify many small customers to get those discounts (Dietl & Waller, 2002). Dietl and Waller (2002) provides substantial evidence that if companies implemented these models, customers could see a price reduction of 16 percent for mail services.

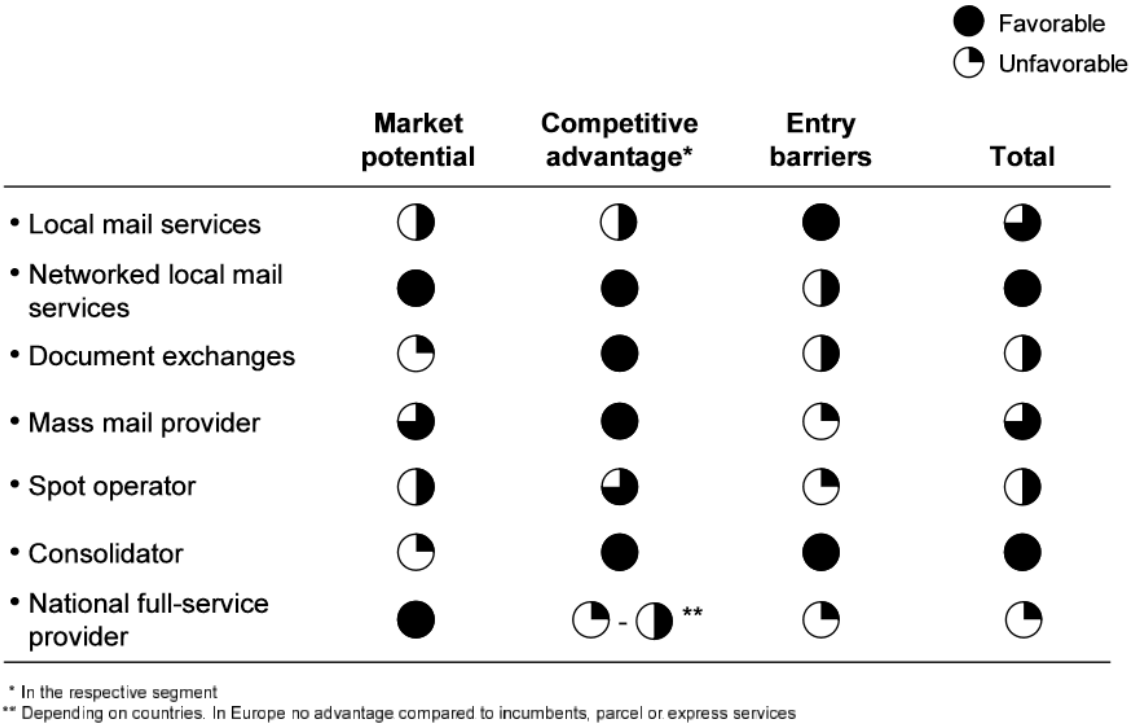

Figure 3. Assessment of New Entrant's Business Models (Dietl & Waller, 2002)

In 2015, UPS had a net revenue of $9.5 billion with over 18 million daily deliveries on average in the world (UPS, 2016). The company began in 1907, as American Messenger Company, when most people did not have telephones or cars and the best way to communicate was public telephones or messenger services (Lukas, 2003). UPS got their start using the method of networked local services in Seattle, Washington. The company expanded services to Oakland in 1919 and then to San Francisco in 1922, before having service to every address in the United States in 1975 (Lukas, 2003). That same year, UPS expanded its operations internationally to Germany. Today's operations require more than 100,000 vehicles and 1,800 operating facilities with over 440,000 employees (UPS, 2016). This makes it difficult to provide these services to such a widespread customer base. Even with stark competition from FedEx and DHL, UPS has managed to hold onto 75% of U.S. ground services market (Lukas, 2003).

UPS held a culture of employee and customer leadership by avoiding public trading until 1999; previously, only UPS supervisors and above could buy stock in the company (Lukas, 2003). Even when UPS went public in 1999, only 10% of their total shares were offered to the public. UPS is all about efficiency, even instructing their drivers to put on their seat belt with their left hand while starting the truck with their right hand (Lukas, 2003). UPS emphasizes its efficiency by implementing training programs that instruct drivers which foot they should put in the truck first to minimize the time between boarding and driving (Ross, 2001). This efficiency has not come without bumps, including the company's only nationwide strike in 1997 (Cabell, 1997). Cohen and Prusak (2001) emphasize, "It's very demanding work, like boot camp or military training. Some workers feel more loyalty to the Teamsters than to UPS." Devoted to his company and customers, founder James Casey served as CEO until 1962 and stayed on the board until his death in 1983 (Lukas, 2003).

Not much has changed over the lifetime of the postal service industry in terms of disruptive innovation in technology. UPS is trying to beat the competition and stay on top of the market by integrating internet capabilities with their services. In terms of e-business initiatives, UPS is working on providing vendor software packages, downloadable functionality on their website, and creating an e-Ventures group to seek out new business opportunities (Ross, 2001). UPS does not want to be left behind in the digital age. The robust infrastructure of UPS makes it very challenging to move quickly at implementing these e-business solutions. UPS invested more than $11 billion in information technology between 1986 and 1996, which included an increase from 100 to over 4,000 information technology employees (Ross, 2001).

One of UPS's first major technology ventures was implementing a tracking feature for customers and vendors. Not only did this make customers more reassured of their packages, but

UPS saw a huge reduction in call center traffic. Web inquiries for tracking cost UPS about ten cents, where call center costs were over two dollars each (Ross, 2001). One can imagine this saves the customer time and money since a web inquiry takes less time than waiting on the phone and possibly being transferred several times.

By 2000, UPS had developed six online tools for customers, which included over 30 additional services (Ross, 2001). In the same year, UPS launched its first e-Venture, UPS e-Logistics, a brand that would provide the entire back-end logistics for a company (Ross, 2001). This included services such as warehousing, inventory management, order fulfillment, shipping and delivery, management reporting, returns management, customer care, and telephone support. Clearly, UPS does not want to fall behind in the technology arms race of the packaging industry and is looking to advance their customer service techniques based on the founding company values.

DHL was founded in 1969 with the purpose of providing international express mail services, starting with a San Francisco to/from Honolulu route. Through the 1970s, DHL was the only company offering overnight international mail services and stood as the third largest courier behind FedEx and UPS with a 38% market share (DHL, 2015). DHL started U.S. domestic services in the 1980s. Today, DHL operates in more than 220 countries and territories with 17,000 courier vehicles and 71,000 employees (DHL, 2015). They operate out of over 4,000 offices and 36 hubs with 250 aircraft around the world (DHL, 2015). Deutsche Post World Net acquired a majority share of DHL in 2001 to extend the company's brand. Founders Adrian Dalsey, Larry Hillblom, and Robert Lynn got their start by taking advantage of the fact that customs would inspect air freight first every morning, thereby allowing for faster shipping times and fewer delays in customs.

In 2003, Deutsche Post acquired Airborne Express to expand its domestic U.S. business, but this failed when it resulted in a less than ten percent market share in the U.S. (Dade, Roth, & Esterl, 2008). Through 2008, DHL U.S. Express operated at a 24% loss and topped out at a $1.9 billion loss in 2008 (Dade et al., 2008). Customer service was at an all-time low with a high rate of customer complaints and an unacceptably low on-time delivery rate of 90% (Mocker, Ross, & Ciano, 2014). Their U.S. shipping business was in trouble so a change had to be made within the company. In February 2009, DHL officially exited the U.S. domestic shipping services with a statement from CEO Ken Allen, "We have now refocused fully on our core competency – the international express business" (Doss & Credeur, 2011). DHL could now focus entirely on what they did best – international shipping services. The U.S. domestic market was now left to be ruled by UPS and FedEx, who both saw an increase in profits and stock prices (Mocker et al., 2014).

The FedEx idea began in 1965 when its founder, Frederick Smith, wrote his thesis on how a system should be designed outside of passenger air shipping routes to accommodate more time-sensitive shipments (FedEx, 2016). FedEx began operations on April 17th 1973 when 14 planes took off from Memphis and delivered the first 186 packages to 25 cities along the east coast (FedEx, 2016). FedEx continued to grow and in 1983 became the first U.S. company to report $1 billion in revenues within 10 years of startup. In 1984, FedEx began its first international service to Europe and Asia (FedEx, 2016). The U.S. Postal service created a partnership with FedEx in 2001, where FedEx would handle some air transportation of U.S. mail and FedEx drop boxes would be placed at post offices around the country (FedEx, 2016). Today, FedEx delivers to more than 220 countries and territories (FedEx, 2016), with revenues exceeding $50 billion in 2016 (FedEx, 2016). They now hold the title of world's largest airline cargo carrier.

Summary

This chapter provided a review of relevant literature. It began with an overview of the SLV industry to understand the major companies involved and their history, before providing more information about SpaceX and Elon Musk. Innovation, value innovation, and leadership traits related to innovation were then reviewed. Finally, the chapter briefly discussed reusable launch vehicles and then explored the postal service industry because of its parallels to the SLV industry and how a company broke into it.

III. Methodology

The purpose of this chapter is to provide details about the methodology used to collect and analyze data for this research. SpaceX is an entirely privately funded company and for this reason there is little to no data released about the company's earnings or financial standing and most of its design decisions, thus making it difficult to perform statistical analysis. This led to a more qualitative research approach where SpaceX was compared to other companies who used similar techniques to succeed. Once a repository of data was collected on different companies and how they compare to SpaceX, the most important aspects of SpaceX that have led to its successful entry into the Space Launch Vehicle industry can be identified.

The methodology employed in this research builds theory based on the case study approach applied to the postal service industry. Research shows that there is a defined process for building theory from case studies (Eisenhardt, 1989). The first step in the process is to define research questions, which were outlined in Chapter 1. In the second step, cases are selected based on theory. This research used the postal service industry as the primary case because of similarities in the barriers to entry and companies that overcame these barriers. The third step defines how data was collected. In this research, data was collected in the form of press releases and general media released by and about SpaceX, but there is a lack of peer-reviewed articles directly related to SpaceX and these concepts. The fourth step is where the data that was collected is meshed with the analysis. This step was performed when the methods of comparison were constructed. The fifth step in the process is where the data was analyzed, using methods from the previous step. The sixth step, shaping hypotheses, was not applied in this research because a hypothesis was not utilized. There was a lack of academic literature on the Space Launch Vehicle (SLV)

industry and SpaceX, which made the seventh step, enfolding literature, difficult to accomplish. The final step, outlined in Eisenhardt's (1989) research, is when closure has been reached and the results are exhausted.

The methodology began by collecting data through a literature review. Data were collected in the form of academic research on the topics related to the research, which provided the basis for answering the research questions. Once the grounds to answer the research questions were established, the data collection effort moved to identifying other relevant companies and industries and collecting additional qualitative data to compare against. The theories identified as the basis of the research questions were then used to determine if the selected companies and industries fit into those theories. This creates the foundation of data to be compared to SpaceX and the Space Launch Vehicle industry. The actions of SpaceX were then compared to the principles and guidelines revolving around the research questions. SpaceX was directly compared against these principles when possible. If there were gaps in data from SpaceX, relevant information about other companies and industries was supplemented and compared to SpaceX.

After the literature review, this research followed a series of smaller methodologies to arrive at the results. Figure 4 shows how the methods of comparison are linked to specific research questions and results. *Stewardship theory* and a comparison of the leaders provided the motivation for entry into the SLV industry. Once the motivation was defined, an industry analysis and comparison was used to determine the barriers to entry and how they could be overcome. SpaceX was compared to the five guidelines Buzzel (1983) outlined for determining if vertical integration is profitable. Additionally, the technical challenges defined by Ward (2000) were used to evaluate SpaceX's current implementation of Reusable Launch Vehicles

(RLV). Those methods facilitated an understanding of the techniques implemented by SpaceX and their effectiveness. Finally, SpaceX's value of innovation was analyzed using the concepts of balancing micro cultures and value innovation. SpaceX was compared to research done by Kim and Mauborgne (1999), wherein a series of red flags, questions for evaluation, and components of successful value innovative companies were outlined.

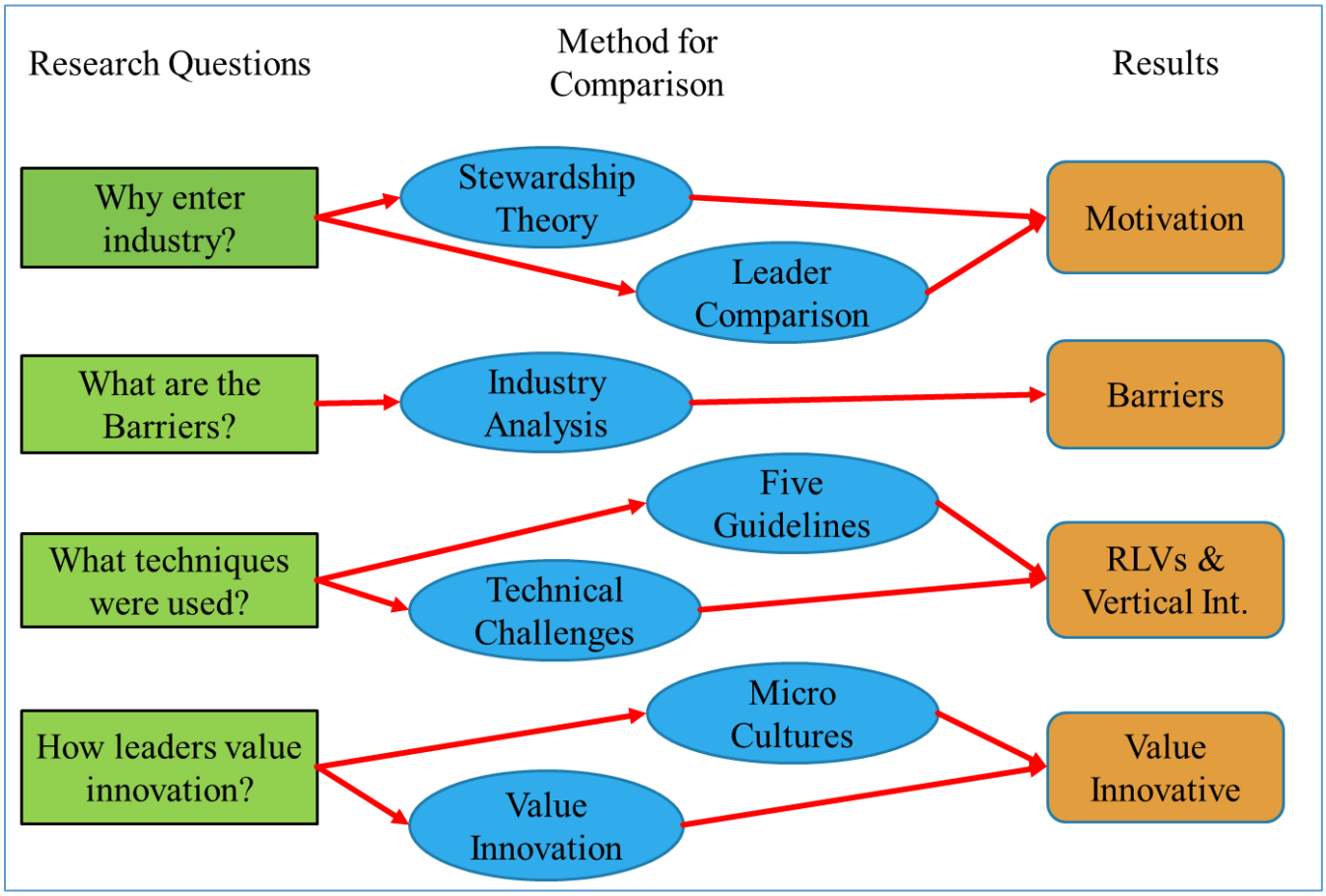

Figure 4. Methodology

Once all the data from the theories and industries had been evaluated, the research questions could be answered. Using the data analysis, a set of recommendations were created and provided. The recommendations were designed to help the U.S. Air Force detect which aspects of a company can lead to better competition in the SLV industry. This information will be useful in encouraging competition in the SLV industry with the goal of further diversifying the industry and lowering prices for the U.S. Air Force.

Summary

This chapter provided a breakdown of the methodology employed in this research. An overall qualitative technique was used to compare SpaceX to other companies and principles relevant to overcoming the barriers to entry in a tightly controlled industry. The first step was to collect data about the theories relevant to the research. Data was also collected on companies that successfully entered other tightly controlled industries. Analysis of the data was done in the form of qualitative comparison to discover what gave SpaceX the ability to enter the industry.

IV. Analysis and Results

This chapter provides the results and analysis of the research. The first section analyzes the barriers to entry into the Space Launch Vehicle (SLV) industry. Then, the innovative techniques implemented by SpaceX are analyzed in terms of their impact on success. The concept of value innovation is used to evaluate the practices of SpaceX leadership. Additionally, the research explores why a founder would want to enter an industry that is tightly controlled with high barriers to entry. Finally, the chapter summarizes the analysis and results by answering the investigative questions.

Results

The results of this research are broken up into sections directly relating to the research questions. It requires a strong motivation to enter a tightly controlled market. The barriers are the next concept a company must consider when entering any industry. Once the barriers are understood, a company will often apply some form of innovation to set themselves apart from the competition and break into a tightly controlled industry. Even when a company has a plan to implement some form of innovation, they must understand the value of that innovation and how to support that idea. The following results will be used to answer the investigative questions laid out in Chapter I.

Motivation to enter a tightly controlled industry

Barney (1990) showed that there are two theories regarding what motivates an organization's leaders: stewardship theory and agency theory. Agency theory tends to be widespread in large

companies who fail to innovate effectively (Davis, Schoorman, & Donaldson, 1997). If Musk is motivated by innovation and a selfless desire to advance society, then he should be a better fit for the opposing stewardship theory. A steward will put the good of the company before his/her own gain. Musk nearly bankrupted himself; after the third SpaceX failure, the company was out of money and there was nothing to attract additional money from investors. Therefore, Musk took the last bit of money he had from selling PayPal to pay his employees and fund a fourth launch, which succeeded (Lubove, 2003). Musk was willing to risk everything he worked hard to get from his other ventures to make sure SpaceX had one more shot at success. Many financial experts thought Musk was insane for putting his last bit of money into a company that already had three huge failures (Jacoby, 2011). Davis' (1997) research showed that a steward will react to situations based on psychological motivations and personal perceptions of the situation as opposed to financial gain.

Additional research has explained that founders are most likely to be stewards because the company is based on their vision and they are unlikely to conform to shareholders (Wasserman, 2006). SpaceX has discussed taking the company public several times to raise more money for the company, but Musk has stated that he does not want to take the company public until the goal of getting humans to Mars becomes a reality because he does not want the company to be forced to act in the interests of monetary gain (Jacoby, 2011). Musk is an industry steward in that he has shown he is willing to risk everything he has for the good of the company and to reach their goal of making humans a multi-planetary species.

It is very difficult for a visionary to enter a tightly controlled industry. Smith entered the postal service industry and managed to succeed despite the high barriers to entry. He spent years researching the industry and developed the concept of using an airliner to only deliver packages

(FedEx, 2016). After publishing the research, his professor discarded the idea and told him it would never work. This motivated Smith to make his dream become a reality. The technology of transporting packages before FedEx is relatively the same. Trucks, planes, boats, and trains are still how mail is delivered. Smith broke into this market because he knew the process could be sped up by using planes dedicated to delivering packages and creating his own delivery routes instead of being confined to the schedules of commercial airliners. FedEx thus became a reality because of one man's vision and determination to revolutionize the industry and provide a superior service. Without Smith, delivering a package across country could still be a very slow and complicated process.

Similarly, Musk had many reasons to enter the SLV industry despite the high barriers to entry. The dream of Musk and SpaceX is to eventually make humans a multi-planetary species, not to become a profitable SLV service provider. If Musk wanted to colonize Mars, he had to first get people and equipment to Mars. The cost to get to low earth orbit let alone Mars was astronomical and made colonizing Mars impractical. The profit margins in the SLV industry were huge, so cutting into those margins would allow for a significantly less expensive SLV. This was the founding principle of SpaceX – build a more affordable SLV to eventually colonize Mars. Like Smith, Musk had a vision and saw room to revolutionize an industry. Musk slashed profit margins and implemented vertical integration to create a low-cost solution at a higher volume, whereas Smith significantly decreased the time to deliver a package.

Musk's desire to advance society allowed him to ignore the difficult path that would be ahead of SpaceX to enter the SLV industry. If the technology hurdle could be overcome, there was additionally a lot of money to be made by cutting into the high profit margins of the industry. At an 80% profit margin, Musk could provide a less expensive option not only to

himself but to other potential customers (Fernholz, 2014). There was no other option for Musk to make his dream a reality. The current SLV offerings were far too expensive so he either had to let his dream go or break into the SLV industry. Musk has not only allowed more customers to take advantage of SLV services, but he is forcing the existing SLV providers to adapt and compete.

Barriers

Parcel delivery is an industry with some of the oldest and most difficult barriers to entry to overcome. This industry started in 1775 when the United States Postal Service (USPS) was established by Congress. There was no other major player or competition for over 100 years until the United Parcel Service (UPS) started in 1907. Then, the industry was stale again until the 1970s when both Dalsey Hillblom Lynn Express (DHL) and Federal Express (FedEx) entered the industry. This industry has a huge cost of entry because of the elaborate and overwhelmingly large infrastructure required to deliver packages. Additionally, the USPS is a non-profit government organization so they are already operating with extremely low margins. With the USPS enjoying over a 100-year head start and the backing of the U.S. government, UPS and later DHL and FedEx had a huge challenge to break into this market.

UPS broke into this market by starting small and only providing services to a high-density area. Research (Dietl & Waller, 2002) showed that this is one of the few ways to break into this industry. UPS leveraged their ability to focus on a small area and deliver packages faster and cheaper than the national alternative provided by the USPS. Over time, UPS scaled up their operation to more large cities and eventually reached the entire country by 1975. This reinforces the huge infrastructure barrier in the postal delivery industry; it took almost 70 years for UPS to

establish a fully functional infrastructure. UPS played the long game by banking on the fact that customers wanted a faster option for larger packages and getting established in high density cities.

DHL entered the industry by taking advantage of the fact that customs would inspect goods from aircraft before boats for international shipping. Their goal was not so much to compete directly with UPS and the USPS but to specifically provide faster overseas shipping. In fact, when DHL eventually expanded into the domestic shipping market, they failed and withdrew only a few years later (Doss & Credeur, 2011). This research shows that the reason DHL was able to enter the industry was because they found a niche part of the industry and could take advantage of a loophole in the customs process.

FedEx had a much larger task in front of them since their goal was to take on UPS and the USPS directly. Before FedEx, both UPS and the USPS would ship packages in the cargo area of commercial flights, thus limiting them to already established routes. Fredrick Smith, FedEx founder, recognized that this was a very slow process. FedEx thus broke into the market by being the first company to ship packages using dedicated cargo planes that were not bound to commercial flights. Additionally, regulations were not as stiff when solely transporting cargo.

All three of these companies broke into the postal service industry by recognizing a unique innovation and basing the company on that idea. UPS avoided huge startup costs by only providing services in a high-density city before expanding as they gained capital. DHL started at a low-cost point by taking advantage of the customs process and only operating in long distance shipping. FedEx risked a large amount of money with a $100 million startup cost to purchase a fleet of cargo planes. This worked out in the end because no other company thought of this idea and simply could not compete in terms of delivery time.

The barriers of entry into the SLV industry parallel many of the postal service industry barriers. One of the greatest barriers to entry for the SLV industry is cost. Just looking at the customer's point of view, a single launch will cost tens if not hundreds of millions of dollars in the case of larger payloads. There are three United States companies with operational SLVs: SpaceX, United Launch Alliance, and Orbital ATK. Musk started SpaceX with an initial personal investment of $100 million (Fernholz, 2014). United Launch Alliance is a joint venture between aerospace giants, Lockheed Martin and Boeing, thus making it nearly impossible to determine their initial investments for the new combined company. Orbital ATK was formed when Orbital Sciences Corporation and Alliant Techsystems merged, making it once again impossible to determine their initial investments. Previous research showed that cost is best categorized as a deterring barrier and is closely related with hampering innovation, but it also has a minor correlation as a revealed barrier (D'Este et al., 2012). Small or new companies struggle with this barrier because capital is normally limited. Research has also shown that cost is the single greatest barrier stopping new companies from attempting to compete in high cost to enter industries. FedEx overcame this barrier by gaining the support of investors and starting with $100 million. Similarly, SpaceX overcame the cost barrier with the $100 million investment of Musk. Since cost is related to revealed barriers as well, increased knowledge and expertise can help overcome the cost barrier. These companies overcame the cost barrier with huge investments and this is the starting point for their success. They both also leveraged some techniques used to overcome revealed barriers. FedEx capitalized on using cargo planes to transport packages. Later, this research will show some of the techniques SpaceX employed that also helped overcome the cost barrier.

Entering the SLV industry requires understanding exactly what is needed to launch a payload into space. A potential SLV provider needs to find a location to launch, acquire or build an actual SLV, and perform extensive tests before even marketing their product and services to potential customers. FedEx also faced similar problems in terms of understanding the details of the postal service industry. This best aligns with the knowledge barrier. Research by D'Este et al. (2012) shows that the knowledge barrier is primarily a revealed barrier and can be overcome by adding industry experts to the company and learning about the industry. Smith did thesis research on the postal service industry and even laid out the basis of what would become FedEx's model to success (FedEx, 2016). Smith thus overcame the knowledge barrier in the postal service industry with extensive self-research. Similarly, Musk was always seeking knowledge and spent a lot of time reading and studying on his own about rocket technology and space (Fernholz, 2014). Since he did not have any actual experience with rocket technology, Musk recruited Tom Mueller, a rocket hobbyist and propulsion engineer (Belfiore, 2009). At the time, Mueller was working on a liquid-fuel rocket engine, and Musk had learned that liquid propellants were cheaper than solid rocket propellants but that the technology was much more complex (Belfiore, 2009). Musk recognized the experience and expertise Mueller possessed and the potential to reduce cost by perfecting liquid-fuel engine technology. This allowed SpaceX to overcome the knowledge barrier. Using similar techniques of self-research, both Musk and Smith overcame the knowledge barrier to push their respective companies to break into a tightly controlled industry.

Researchers show that market barriers fall mostly under the deterring barrier category because if a market is very tightly controlled it is an uphill battle for startup companies to overcome this barrier (D'Este et al., 2012). The postal service industry had been very stale and

unchanged before FedEx entered the industry. The USPS had a 200-year headstart on FedEx and UPS was about 70 years ahead. DHL was a minor player in the U.S. postal service industry when FedEx started but was focused on international shipping; it was also a newer company. The market at large did not have a need for another player in the industry since USPS and UPS could handle the needs of most customers in the U.S. However, FedEx was able to overcome the market barrier by recognizing that there was no fast shipping option for time sensitive goods such as medicine (FedEx, 2016). FedEx subsequently inserted itself into this segment with operations initially only on the east coast but later expanded across the entire country. SpaceX faced a similar situation wherein the market was stale with only a few companies that could trace their roots back to the first SLVs. The industry did not change much over the years other than name changes and mergers. To overcome the market barrier, SpaceX had to discover what could separate itself from the well established competitors. SpaceX subsequently planned to offer the lowest cost SLVs ever by leveraging vertical integration and reusability (SpaceX, n.d.). Offering a significantly lower cost is one of the simplest ways to overcome the market barrier (D'Este et al., 2012). SpaceX, similar to FedEx, thus proved that a tough market barrier could be overcome.

There are also numerous regulations to follow before the first launch which have significant costs associated with them. For example, the Federal Aviation Administration (FAA) requires a license before any space launch can occur by U.S. citizens anywhere in the world or by any entity within the U.S. (Federal Aviation Administration, 2016). In the words of the FAA (2016), "A launch or reentry specific license authorizes you to conduct one or more launches or reentries having the same operational parameters of one type of launch or reentry vehicle operating at one launch or reentry site." The application process consists of seven steps that any SLV

manufacturer must follow. The first step is to complete pre-application consultations; this consists of communication between the launch provider and the FAA to help the applicant familiarize themself with the process and help the FAA understand any unique aspects of the launch. The launch provider then moves on to the launch vehicle policy review and approval. In this step, the FAA, with the help of other government agencies, determines if the launch will present any issues affecting U.S. national security or foreign policy. Step three is the launch vehicle safety review and approval where the FAA determines "whether you [SLV provider] can safely conduct your proposed operation" (Federal Aviation Administration, 2016). Step four is the payload review and determination where it is determined whether the payload owner has obtained all appropriate licenses. The financial responsibility determination step (step 5) uses a Maximum Probable Loss (MPL) calculation to determine a worst-case scenario in terms of money lost by the government and third parties due to a launch failure. The SLV provider must provide a way to account for this loss by showing proof the company has financial reserves equal to or greater than the MPL, placing an amount equal to the MPL in an escrow account, or buying liability insurance equal to the MPL. The FAA encourages companies to purchase the liability insurance (Federal Aviation Administration, 2016). In the environmental review step (step 6), the FAA will consider alternatives to the launch that may protect the environment. The final step (step 7) of compliance monitoring occurs after the license has been issued and is in place to ensure the SLV provider is following all rules and regulations and acting in accordance with the proposal.

D'Este et al. (2012) show that regulation barriers have a minor correlation with deterring effects but a much stronger correlation with revealed effects. Revealed barriers are best overcome with an increase in knowledge and learning (D'Este et al., 2012). This means the best

way for SpaceX to overcome the regulations is to learn everything they can about the process and about other companies that have gone through the process. SpaceX's first license took more than a year from start to finish and was the first license ever issued to a commercial SLV company (Klamper, 2010). This shows the application process is very prohibitive and was quite a feat the first time SpaceX completed the process.

Even though regulations can be very prohibitive, several government actions have helped companies overcome the regulation barriers. The Office of Commercial Space Transportation was established in 1984 to regulate the U.S. commerical space transportation industry and create a line of communication between commerical space companies and the government (Federal Aviation Administration, 2016). The Commercial Space Launch Amendments Act of 2004 allowed commercial companies to let passengers fly on suborbital launch vehicles (Boyle, 2004). Even though this did not directly affect SpaceX, it was a huge leap for commercial spaceflight. This allowed a more open industry and a new set of potential customers. Prior to this Act, many investors were wary of entering the industry due to fears that government regulations would hamper their innovations and the potential to create a new industry of public space transportation.

Looking to the postal service industry, it is possible to overcome high barrier industries even as a small startup company. To make a true comparison between variables, one must control the other variables as much as possible. In this case, it is important to establish the similarities in these two industries (variables) to compare how a company can break into each respective industry. There must be a plan in place before investing large amounts of money since that is the first barrier to entry. Both industries have extremely high costs to enter and have well established competitors. Even though there are giant companies controlling the industries, there

is not an over saturation of competitors, thereby leaving room for disruptive innovation. The SLV and postal service industries both have significant government regulation involved, which limits some freedom of development and adds to the cost of entry. FedEx and SpaceX had to compete with large companies possessing long-term experience and many ties to the industry.

The SLV industry is a very complex industry with extremely difficult barriers to overcome. The technology to launch a rocket into space is well understood; therefore, the main way to innovate is through incremental innovation, which tends to favor incumbents. The cost to enter this industry is enormous with even greater risk since any return on investment will take years to realize for any single launch. This also means that it is unlikely a startup company can get the funds through normal venture capitalists. SpaceX has overcome this barrier by initially being funded by one person with a passion for the industry. One of the most complex barriers is that of regulation which can take time most of all to overcome. The Office of Commercial Space Transportation has made it significantly easier for companies like SpaceX to understand all the regulations and the process for obtaining a license to launch into space.

Innovative Techniques

Innovation plays an important role in a challenger entering any industry and even more so when entering a tightly controlled industry. SpaceX first utilized vertical integration to reduce the costs of moving and assembling SLVs. Vertical integration is an innovative technique in the SLV industry because it has not been implemented on any significant scale. SpaceX is also well underway to develop a fully-reusable SLV to eliminate the cost of rebuilding most of the SLV after every launch. While these innovative techniques are not new concepts in general, SpaceX is the first SLV company to employ these techniques into their business and development model.

When Musk was upset by the high cost to buy an SLV from Russia, he roughly determined there was more than an 80% profit margin on the current industry of building SLVs. He subsequently decided he could do most of it himself and just take a lower profit margin by using vertical integration (Fernholz, 2014). Based on data from 1,649 businesses, Buzzell (1983) determined there are five guidelines for evaluating whether vertical integration is profitable for a company. This research compared each of those five guidelines to SpaceX and the SLV industry to determine if SpaceX made the right choice to vertically integrate.

The first guideline suggests that a company must be aware of high investment costs and expect a small return on investment initially as well as a decrease in profit margins to get the vertical integration started (Buzzell, 1983). Musk had $100 million of his own money to invest initially and discovered that the current process allowed a company to enjoy an 80% profit margin (Fernholz, 2014). This means SpaceX had the high initial investment required for vertical integration and could afford a significantly lower profit margin. Furthermore, since it was his own money, Musk did not have to convince investors that this strategy would be profitable in the long run. SpaceX was ready for the high investment cost and prepared for a decrease in return on investment and profit margin.

The second guideline suggests considering alternatives to owning all steps of the process, such as long-term contracts with suppliers, and that this can often result in many of the same cost benefits as vertical integration (Buzzell, 1983). Musk tried multiple times to form relationships with suppliers of SLVs and was either discouraged for his lack of knowledge of the industry or offered huge prices to purchase SLVs (Fernholz, 2014). SpaceX's mission was not to revolutionize the SLV industry or even break into the market. They wanted to enable people to live on other planets and were more than willing to use other companies for their SLVs. It just

turned out that the least expensive way to work toward that goal was to vertically integrate and own most of the process.

Buzzell's (1983) third guideline shows that it is best to avoid only partial vertical integration and even shows data that most profitable companies fall on the extreme of either no vertical integration or an all-in approach, as shown in Figure 5. SpaceX manufactures and assembles more than 70% of their Falcon SLVs in-house (Bergin, 2015). In addition to the hands-on part of the process, SpaceX is responsible for all phases of the life-cycle, including design, software, integration, testing, and launch/orbit operations. In comparison, ULA only provides systems integration and launch operations with over 1,200 subcontractors across the country (United Launch Alliance, 2015). Figure 5 shows that a company that vertically integrates over 70% is in the higher category and on average can expect a 24% net profit as percent of investment (Buzzell, 1983). SpaceX fits into the top end of vertical integration and is committed to its business model.

Exhibit I Vertical Integration and Profitability

Vertical integration measured by adjusted VA/S	Net profit as percent of sales	Investment as percent of sales	Net profit as percent of investment (ROI)	Number of businesses
Under 40%	8%	38%	25%	267
40%–50%	8	45	22	341
50%–60%	9	54	20	389
60%–70%	10	56	22	338
Over 70%	12	65	24	314

Figure 5. Vertical Integration and Profitability (Buzzell,1983)

The fourth guideline tells companies to carefully analyze scale requirements before implementing a vertical integration strategy. As shown in Figure 6, it is on average not as profitable for companies with a low (under 25%) market share (Buzzell, 1983). This is one place SpaceX has strayed from the guidelines. SpaceX implemented vertical integration from the start with a zero percent market share. This was very risky since SpaceX did not have any real experience in the industry. However, the idea to vertically innovate should be considered a breakthrough innovation because no one else in the industry was using this technique. This also ties back to overcoming the barriers because using a vertical integration strategy meant that SpaceX did not have to rely on suppliers that were providing for the competition. SpaceX could ignore this guideline and use vertical integration to help the fact that they were an inexperienced company.

The last guideline suggests that a company should be skeptical of the idea that vertical integration will reduce raw material costs (Buzzell, 1983). Initially, Musk did not intend to vertically integrate and wanted to buy rockets from other suppliers. SpaceX did not implement the vertical integration strategy to reduce the cost of raw materials. Their reason for implementing vertical integration was to reduce operation and assembly costs. SpaceX has parts suppliers in all 50 states but they have a rigid supplier/contractor policy (SpaceX, n.d.).

Exhibit IV **Vertical Integration, Relative Market Share, and Profitability**

Vertical Integration	Relative market share*					
	Under 25%		25%–60%		Over 60%	
	Average ROI		Average ROI		Average ROI	
Adjusted VA/S						
Under 50%	14%	(235)†	26%	(202)	33%	(171)
50%–65%	14	(188)	19	(204)	29	(188)
Over 65%	9	(113)	22	(150)	31	(198)
Relative backward integration						
Less	14	(193)	24	(139)	30	(90)
Same	13	(293)	21	(351)	31	(363)
More	11	(50)	23	(66)	34	(104)
Relative forward integration at company level						
Less	14	(110)	27	(84)	29	(78)
Same	13	(361)	22	(396)	31	(408)
More	15	(65)	19	(76)	34	(71)

*Relative market share is a business unit's market share, expressed here as a percentage of the combined share of its three largest competitors.
†The number of businesses is shown in parentheses.
Note: The differences among the three market-share groups are statistically significant at the 99% probability level. In a multiple regression model that includes all major PIMS profit determinants, the coefficient of VA/S is negative but insignificant for small-share businesses. For businesses with relative shares above 25%, VA/S has a significant negative coefficient ($p > 0.99$) and $(VA/S)^2$ has a significant positive coefficient ($p > 0.99$).

Figure 6. Vertical Integration, Relative Market Share, and Profitability (Buzzell, 1983)

In addition to implementing vertical integration, SpaceX plans to eventually utilize a Reusable Launch Vehicle (RLV) to reduce the total cost of a space launch. Musk has even gone as far to say, "If one can figure out how to effectively reuse rockets just like airplanes, the cost of access to space will be reduced by as much as a factor of a hundred. A fully reusable vehicle has never been done before. That really is the fundamental breakthrough needed to revolutionize access to space" (SpaceX, 2015). This article containing this quote also emphasizes that the cost of the Falcon 9 SLV is about the same as a commercial airliner, but the airliner can fly multiple

times a day for years. Even though they have yet to perfect their technology, SpaceX rockets are designed to withstand reentry and return to a landing site (SpaceX, 2015).

Using Ward's (2000) research as the basis for analysis, SpaceX has overcome most of the technical challenges of creating RLVs. The first challenge is creating a thermal protection system for the SLV since it will be reentering the earth's atmosphere. Ward (2000) explains that the typical surface temperature of reentry is 3,000 degrees Fahrenheit with the surrounding air around 20,000 degrees Fahrenheit. To put this in perspective, aluminum starts to melt at about 1,200 degrees Fahrenheit and Titanium at about 3,000 degrees Fahrenheit (Ward, 2000). SpaceX implements a twofold approach to dealing with the extreme heat. First, SpaceX uses a reignition system to slow the rocket down on reentry and guide it down to earth safely (SpaceX, 2015). Second, SpaceX guides the rocket down to earth in an orientation that faces the engines, which are already capable of extreme heat at launch, toward earth. This solution allows SpaceX to design SLVs with a reduced weight and avoid heavier materials or shielding similar to what was used on the space shuttle.

The next challenge Ward (2000) points out is a reusable propulsion system. His research even emphasizes that this is the greatest challenge for any commercial company because nothing has been developed that can withstand the desired operability and reliability required for RLVs. SpaceX has opted to create their own rocket engine in-house and use multiples of these engines for their SLVs to save cost. SpaceX has not released the details of their engine design, but they did create a new engine capable of reentry and reusability and have proven its capability with return flights (SpaceX, 2015).

Ward (2000) mentions another technological challenge for RLVs is the type of propellant. At the time of his research, JP-8 and liquid oxygen was the most common combination for SLVs.

Liquid oxygen is still used by SpaceX for reusable launches since it is very cheap and safe to handle. However, JP-8 is a very toxic jet fuel that has been abandoned by SpaceX in favor of RP-1, which is a much more stable and non-toxic fuel. The fuel combination has been used by many SLVs and is no longer a concern that Ward (2000) emphasized. Through industry technological advancement, health and status monitoring of the rocket is no longer an expensive problem as it was during Ward's (2000) research.

SpaceX has yet to implement a fully RLV but has made many advancements to that goal. The first major accomplishment for SpaceX was their Grasshopper reusability test program where they successfully tested a ten-story vertical takeoff, vertical landing rocket that reached a height of 744 meters before landing back on the launch pad in 2013 (SpaceX, 2015). In 2014, SpaceX tested a Falcon 9 Reusable (F9R), which is just the Falcon 9 first stage with landing legs, and achieved a height of 1000 meters. In 2015, SpaceX successfully delivered several payloads to orbit and then landed the first stage back on earth but experienced difficulties with the landing. Finally, in 2016, SpaceX delivered a payload to orbit and then returned the Falcon 9 first stage to a drone ship in the Atlantic, thus demonstrating a huge proof of concept for SpaceX (SpaceX, 2015)

SpaceX has successfully broken into the SLV industry in large part due to their innovative techniques and technologies. Vertical integration was successfully implemented in an industry that had never considered the technique viable. Therefore, SpaceX can produce SLVs at a significantly lower cost by doing most of the work and operations in their own facilities. RLVs have been researched and given some consideration in past systems but they have never been taken as seriously as SpaceX is taking them. SpaceX has progressed more than any other

company or organization in implementing its innovations into a fully RLV. SpaceX is founded on the expertise of its staff and innovative nature to tackle a previously stale industry.

The Value of Innovation

SpaceX has made several fundamental decisions to set them apart from the SLV industry as a value innovative company as opposed to a competitive nature company. Looking back at the literature, SpaceX can be evaluated based on two questions (Kim & Mauborgne, 1999). The first question asks if the company is offering customers radically superior value. Currently, United Launch Alliance (ULA) is the only other SLV provider used by the U.S. Air Force and charges an average of $225 million for launch services using up to a Delta IV Heavy (United Launch Alliance, 2015). A Delta IV Heavy can carry a payload of up to 29,000kg to Low Earth Orbit (LEO). ULA claims the cost of a single launch will be less than $100 million with their block buy agreement with the Air Force totaling 36 launches (United Launch Alliance, 2015). SpaceX offers 54,000kg to LEO on a Falcon Heavy for $90 million as a one-time purchase (SpaceX, 2016). The ULA price is based on an average of all their SLVs and a contracted price. The SpaceX price is their heaviest SLV and they can offer launches on their smaller Falcon 9 for $62 million with a payload of 23,000kg to LEO (SpaceX, 2016). SpaceX notes that "modest discounts are available, for contractually committed, multi-launch purchases" (SpaceX, 2016).

Figure 7 shows these costs and the performance based on orbit selection. Based on this information, SpaceX is offering superior value to customers. They are not only going to beat the competition in terms of actual cost, but they also offer more convenience. SpaceX is not requiring a block buy contract, limiting themselves, or giving a special deal to government customers. This offers customers a less expensive and more flexible option as well as having a

greater customer base than ULA. The second question asks if the company's price level is accessible to the mass buyers in the target market (Kim & Mauborgne, 1999). This follows well from the previous question because in the case of SpaceX their superior value is in the form of cost and convenience and not so much a new technology. SpaceX is a value innovative company because the leadership is determined to offer superior value through their innovative practices.

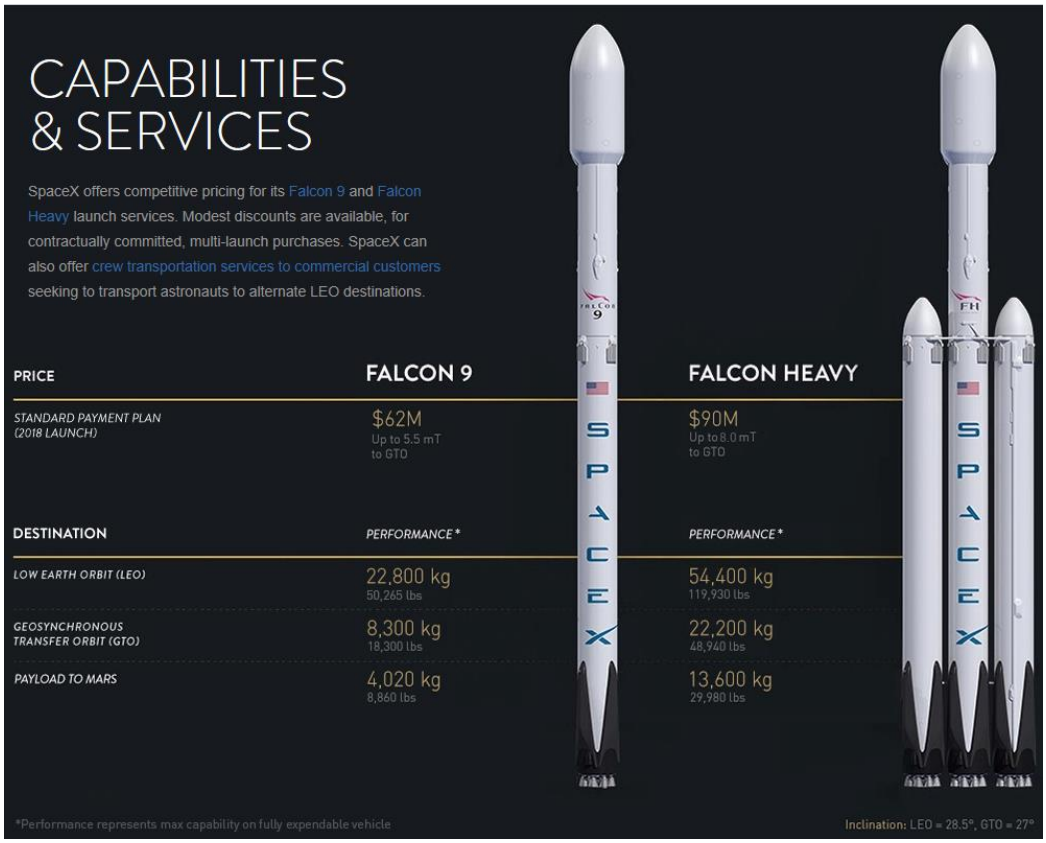

Figure 7. SpaceX Capabilities and Services *(SpaceX, 2016)*

Kim's (1999) research also offered some red flags to indicate when a company is driven by competition and not innovation. The first flag notes that a company will be imitative instead of innovative. SpaceX completely designed their SLVs from scratch with the purpose of offering launch services at an affordable price so that the industry can expand to new customers. The

second unintended effect of a competitive strategy is that a company will act reactively and often respond to frequent competitive moves rather than creating new opportunities for their company to grow (Kim & Mauborgne, 1999). SpaceX is making business decisions separate from the rest of the industry in that their goal is to make launch services affordable and provide a stepping stone for missions to Mars (SpaceX, n.d.). Musk tried to acquire launch services and equipment from other providers for this goal but realized the only way his vision would come true would be to drastically reduce the price of SLVs. The last consequence (or red flag) is that a company's understanding of the mass markets and changing customer demands will become hazy (Kim & Mauborgne, 1999). This is not as easy to evaluate since SpaceX is not actually responding directly to market demands or what the customers want, but this is not due to becoming hazy or not understanding the market. SpaceX is in this industry almost for self-serving purposes to provide a less expensive method of getting to space and Mars in the long run. It is more of a bonus in helping meet their goal to provide more affordable launch services to other customers, but they are their first customer and responding to their needs for the future. Their final goal is in the interest of society and advancing knowledge of space travel to Mars and expanding our livable region. In doing this, SpaceX broke into an industry and is providing services to other customers as a method to raise capital.

The research by Kim and Mauborgne (1999) showed that value innovative companies have two common components to their market approach: strategic pricing for creating demand and target costing for profit creation. SpaceX has strategically priced themselves lower than any other competitor to create new demand from customers who would not normally be able to afford putting satellites into space. Additionally, customers who can afford SLV services can now afford more launches and strengthen their satellite network. This strategic pricing has given

SpaceX the solid reputation of being not just the most affordable SLV provider but also being very reliable. SpaceX is also targeting the cost structure of the SLV industry to create attractive profit margins. Rather than simply cut into their margins to be cheaper than the competition, they have rethought the industry. They are implementing techniques such as vertical integration to minimize costs. This is going to make it extremely difficult for the industry to keep up without significantly changing their respective cost structures and business practices that have kept them on top for decades. SpaceX thus follows the market approach of companies described as value innovators.

Leaders of innovative companies have been identified as properly balancing and enforcing all three types of micro cultures (Zien & Buckler, 2000). The fuzzy front end is easy to identify in companies that express this culture because it is what most customers can see in everyday operations. When SpaceX was founded, many SLV companies and industry experts did not think it was possible for a small company to enter the industry. Musk and SpaceX are in the SLV industry because they enjoy the challenge and are excited to get to the next step in making humans multi-planetary (SpaceX, n.d.). Their desire to use RLVs is an experimental concept emanating from a high tolerance for ambiguity and uncertainty that has already started to pay dividends. SpaceX is embracing the fuzzy front end culture and using it to their advantage. The product development process micro culture has additionally been embraced by SpaceX. They manage to keep a very detailed schedule of launches and keep short-term and long-term goals in mind with all of their operations (SpaceX, 2016). SpaceX understands that time is important for customers who rely on a technology to get to orbit by a specific date. The last micro culture is market operations, which can often be hard for leadership to manage when a company is new and innovative (Zien & Buckler, 2000). Even though SpaceX is implementing radically new

business practices, they have managed to learn the rules of SLVs and abide by the rigorous license process set forth by the U.S. government. Musk and the other leaders at SpaceX have managed to embrace all three micro cultures to in-turn embrace innovation.

Investigative Questions Answered

1. Why did Elon Musk/SpaceX want to enter the SLV industry? How does this compare to other leaders and companies who entered tightly controlled industries?

Musk entered the SLV industry to make his vision a reality. It is important to understand that Musk is a steward in the industry looking to advance his vision. His motivation and desire to enter the SLV industry is based on his desire to make humans multi-planetary. He recognized it was too expensive to do this using the current SLV technology and services. This drove him to create SpaceX and design their own SLVs at a fraction of the price of the current offerings. Smith was in a similar position when he founded FedEx to provide a faster shipping service. Both founders had a vision and were willing to put everything on the line to make their respective visions come true. Any visionary who wants to enter a tightly controlled industry can be motivated by stewardship theory and a goal greater than money at the risk of losing all their investments.

2. What are the barriers of entry into the SLV industry? How does this compare to other tightly controlled industries?

This research has shown that the cost to enter the SLV industry is a strong barrier to entry. SpaceX overcame this barrier by having the financial backing of Elon Musk. This is closely related to the postal service industry and how FedEx broke into that industry. The founder of

FedEx acquired a loan from his father and investors to start the company. The knowledge gap is another barrier of entry into the SLV industry. Elon Musk was not an aerospace engineer nor had he any experience in the field, but he overcame this barrier by learning all he could about the technology and surrounding himself with experts in the field. FedEx approached the barrier in a similar fashion wherein the founder made the industry the topic of his thesis research and relied on self-taught expertise. The SLV industry was part of a very tightly controlled market in which all of the successful companies were part of the industry for many years and had not faced any real competition. SpaceX overcame this barrier by offering a significantly lower priced option to customers. Similarly, FedEx faced a strong market barrier in which the industry had been unchanged for decades. FedEx subsequently offered a significantly faster shipping method to overcome this barrier. Regulations were the last major barrier SpaceX had to face. The SLV industry involves very high priced products that can be used as weapons of mass destruction, which necessitates a great amount of regulation. While it was a slow process, SpaceX overcame this barrier with the help of government organizations put in place to ease the application process and by gaining a lot of knowledge from other experts who dealt with the regulations as part of other companies. FedEx did not have to deal with regulations in the same way; however, the fact that pricing for the USPS was regulated and supported by the U.S. government made it a hard task to compete against. This barrier was overcome by finding a niche in the industry that FedEx could focus on instead of taking on the entire industry.

3. What key innovative techniques did SpaceX implement?

It is nearly impossible to list every innovation SpaceX employed on its road to breaking into the SLV industry, but most of their innovations have come by implementing vertical integration and working towards a fully RLV. SpaceX took clues from other industries such as automobile manufacturing to implement a vertical integration business model. Using vertical integration, SpaceX has not only simplified almost all aspects of the industry but they have also significantly reduced the cost of launching a payload to space. In addition to vertical integration, SpaceX is putting significant research and development towards the utilization of RLVs. They have made many innovative strides in this goal to make SLVs even less expensive. SpaceX has not achieved a fully RLV yet, but they have proven their concept in the first stage and continue their efforts to reduce the overall cost of SLVs.

4. How do SpaceX leaders value innovation versus other industries?

Musk and SpaceX have shown a desire to be a value innovative company and not fall into the typical competitive nature most companies exhibit. SpaceX is offering superior value to its customers in the form of cost and convenience. Additionally, its cost is lower than the competition and attracts more customers to seek the services of SLVs. SpaceX has also managed to avoid the three red flags that companies driven by competition exhibit. They do not simply imitate the other industry leaders nor react to their competitive moves. The last concept in Kim and Mauborgne's (1999) research of innovative companies expressed that all of their innovative subjects had two common components to their market approach. SpaceX's market approach has been to strategically price their products to create new demand and in doing this they have targeted the cost structure of the industry. In addition to following that model of value

innovation, the leaders at SpaceX have shown their ability to balance the three types of micro culture. SpaceX has created an overall culture that embraces experimenting while still staying schedule oriented and following the rules set for the industry. SpaceX is not only an innovative company by nature of their products, but the leadership puts a high value on that innovative aspect.

Summary

This chapter provided the necessary analysis and results required to answer the research questions. The first part of the analysis came in the form of understanding the barriers of entry that SpaceX had to overcome and how these barriers compared to other industries. Once the barriers of entry were analyzed, SpaceX could be evaluated based on the innovative techniques they implemented. The innovative techniques were compared to techniques used in other industries to determine their relevance in overcoming the previously discussed barriers. With an understanding of the innovative techniques used by SpaceX, the leaders of SpaceX could be evaluated on their implementation of innovation. This research then described how the leadership in SpaceX valued innovation and turned to the motivation of the founder, Elon Musk. The final research question focused on why a founder would want to enter an industry with a high barrier of entry. Throughout this research, SpaceX and their actions were continuously compared to other companies that managed to overcome the barriers of tightly controlled industries. This research discovered how and why a company like SpaceX could break into an industry dominated by a few companies.

V. Conclusions and Recommendations

The purpose of this chapter is to provide overall conclusions and recommendations based on this research. The significance of the research and conclusions will also be discussed for the U.S. Air Force. Recommendations for action will also be provided to aid the U.S. Air Force with future involvement in the Space Launch Vehicle (SLV) industry. The last part of this chapter will provide some direction for future research into this topic.

Conclusions of Research

Based on the investigative questions and data analysis performed, the following research conclusions are presented.

1. Elon Musk created SpaceX to make his vision of humans becoming a multi-planetary species a reality. The vision and motivation of the founder is the first and most important factor to keeping a company on track when it faces tough decisions. Musk has become a steward in the industry and is willing to put his personal gain aside to keep SpaceX motivated and on track for its mission. It is his vision that has made SpaceX so successful and ensured their rise in the SLV industry. Affordable SLV services would not even be an idea if it were not for Musk's passion.
2. The largest barrier of entry into the SLV industry is initial startup cost. It does not matter how innovative a technology or business practice is; a company must still have a large amount of capital to enter the industry because of the amount of equipment and understanding of the process required. Musk provided the entire initial investment by using money he earned in previous businesses. The knowledge required to enter this industry is

another extremely challenging barrier since there are not many people with the expertise needed to compete in the industry. SpaceX hired a group of people with knowledge of the industry who were not given a chance to be innovative in other companies. This allowed SpaceX to create a new company full of experience. With the knowledge barrier comes the regulation barrier, which makes it very difficult for any company to understand what is needed to provide SLV services. The U.S. government provides a very detailed path for gaining approval to launch into space and even provides counseling throughout the process.

3. SpaceX implemented two innovative techniques that allowed them to overcome the entry barriers in the SLV industry. First, they implemented vertical integration to reduce cost and development time. This practice was previously unheard of in an industry that had previously prided itself on spreading development and operations among many other companies. Secondly, SpaceX is developing reusable launch vehicles to reduce the cost of entry to space. The hardware is the most expensive part of a space launch, so SpaceX intends to make all of their hardware fully reusable to get as many launches as possible from one physical SLV. SpaceX's innovative techniques are the most significant aspect of the company that has allowed them to compete with companies that have led the industry for decades.

4. SpaceX is a value innovative company that is not looking to make a quick profit or directly compete on the same technologies. Companies often fall into a competitive mindset that hinders innovation by trying to be slightly better than the competition. SpaceX is competing on its own terms and creating new customers as it expands its technology. The three micro cultures are significant to the way SpaceX operates, and they have balanced all three of these micro cultures to stay innovative and competitive in the industry.

Significance of Research

The U.S. Air Force spends on average $225 million on SLV services per launch from the only other certified national security provider (United Launch Alliance, 2015). Prior to SpaceX, this was the only option for the U.S. Air Force and they had little power in terms of price. With SpaceX offering similar services for under $100 million, the U.S. Air Force now has an option in terms of which company to use to provide SLVs for national security missions (SpaceX, 2016). This research allows the U.S. Air Force to understand which aspects of the industry and SpaceX facilitated competition. Additionally, this research should allow the U.S. Air Force to position itself to encourage other companies to enter the market and create greater competition. With this research, the U.S. Air Force can better understand the intricacies of the SLV industry and make better informed decisions about how they are going to spend taxpayer money.

Recommendations for Action

Based on this research, the following recommendations for action are presented to help the U.S. Air Force to encourage more competition in the industry.

1. The greatest barrier to overcome to enter the SLV industry is startup cost. The U.S. Air Force should establish a grant or partnership program that would provide the initial startup costs, on loan, to companies with innovative ideas. Alternatively, the U.S. Air Force could help validate and establish partnerships between companies. This has a high initial cost to the U.S. Air Force, but it will encourage more competition and should result in lower prices across the board for SLV services.
2. SpaceX's biggest reason for being able to cut costs so rapidly was the implementation of vertical integration. Therefore, the U.S. Air Force should encourage vertical integration by

providing subsidies to companies that implement this strategy to consolidate the manufacturing and assembly process. Land could be provided to companies near current launch facilities to decrease the transportation cost of materials. It is still important to keep diversification of raw materials and parts to prevent monopolization.

3. Reusability has been shown to benefit many industries and SpaceX is on the way to reaping these benefits in the SLV industry at their own cost and risk. The U.S. Air Force could provide funding or award contracts for research and development of reusable technologies. SpaceX took this leap on their own and it should soon benefit the U.S. Air Force even more by lowering launch costs.

Recommendations for Future Research

This research has provided a qualitative analysis of the SLV industry and how SpaceX not only competed in this industry but became the leader in the U.S. market. One large place that could use future research is the impact SpaceX has had on the industry in the U.S. and worldwide. Research could provide insight into how ULA will compete with these lower prices in the U.S. and the resulting impact on national security missions. SpaceX has completely changed the way any company is doing business in the SLV industry, and more research could be done on exactly how, if at all, other companies are changing their business models.

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14. ABSTRACT

The Space Launch Vehicle (SLV) industry has been around for a long time, but few companies have managed to enter this industry. SpaceX was founded only 10 years ago, but it has managed to become a leader in the U.S. industry and a dominant player worldwide. The purpose of this thesis research is to discover what it took for SpaceX to break into this tightly controlled industry. A qualitative analysis was performed to compare SpaceX to companies that overcame the barriers of entry for their respective industries. SpaceX, like FedEx, could implement a unique technique to the industry and find success. SpaceX was also evaluated against guidelines and principles presented by relevant research. The results of this research showed that SpaceX, driven by Elon Musk, overcame the barriers of entry primarily through their large initial investment and implementation of vertical integration. This research showed SpaceX adhered to the guidelines and avoided misconceptions associated with implementing vertical integration. Musk, following value innovative principles, is using the concept of reusability to decrease the cost of an SLV. The results of this research show that the U.S. Air Force can aid other companies in the future to create a healthier competition in the SLV industry.

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